Available online at www.sciencedirect.com
SCIENCE DIRECT®
ELSEVIER
Nuclear Instruments and Methods in Physics Research B 235 (2005) xi–xvii
NIM B
Beam Interactions with Materials & Atoms
www.elsevier.com/locate/nimb

# Contents

Editorial . . . . . vii
Committees and supporters . . . . . ix
Photo . . . . . x
Contents . . . . . xi

**1. Highly charged ions: Fundamental aspects, structure and spectroscopy**

QED and the fundamental constants
P.J. Mohr and B.N. Taylor . . . . . 1
Towards electronic *g*-factor measurements in medium-heavy hydrogen-like and lithium-like ions
M. Vogel, J. Alonso, S. Djekic, H.-J. Kluge, W. Quint, S. Stahl, J. Verdu and G. Werth . . . . . 7
Janne Rydberg – his life and work
I. Martinson and L.J. Curtis . . . . . 17

*1.1. Energy levels, QED corrections, nuclear effects*

On the metastable level in Ni-like ions
E. Träbert, P. Beiersdorfer, G.V. Brown, S. Terracol and U.I. Safronova . . . . . 23
Theoretical investigation of the spectrum of TcXVIII
A. Ramonas . . . . . 28
Investigation of the $^4$D metastable state in Na-like ions
D. Strohschein, J. Baran, S. Hossain and J.A. Tanis . . . . . 31
Two-loop self-energy correction to the ground-state Lamb shift in H-like ions
V.A. Yerokhin, P. Indelicato and V.M. Shabaev . . . . . 36
Second-order electron self-energy loop-after-loop correction for low-$Z$ hydrogen-like ions
I. Goidenko, L. Labzowsky, G. Plunien and G. Soff . . . . . 40
QED effects in transition energies of low lying levels for highly ionized boron like ions
K. Koc . . . . . 46
Evaluation of quasidegenerate energy levels of two-electron configurations for multicharged ions
O.Yu. Andreev, L.N. Labzowsky, G. Plunien and G. Soff . . . . . 51
*g* factor of lithiumlike ions
D.A. Glazov, V.M. Shabaev, I.I. Tupitsyn, A.V. Volotka, V.A. Yerokhin, P. Indelicato, G. Plunien and G. Soff . . . . . 55
Hyperfine splitting of hydrogen-like ions and relativistic nuclear model
T. Nagasawa, A. Haga, M. Nakano and Y. Horikawa . . . . . 61

doi:10.1016/S0168-583X(05)00855-4

Hyperfine splitting in heavy ions with the nuclear magnetization distribution determined from experiments on muonic atoms
A.A. Elizarov, V.M. Shabaev, N.S. Oreshkina and I.I. Tupitsyn . . . . . 65
Full-relativistic calculation of nuclear polarization in atomic and muonic levels
A. Haga, Y. Horikawa, H. Toki and Y. Tanaka. . . . . 71
Electric quadrupole moment of a hydrogen-like ion in s and $p_{1/2}$ states
Y.S. Kozhedub and V.M. Shabaev . . . . . 76
Search for Majorana neutrino – a problem for atomic physics
Z. Sujkowski and S. Wycech. . . . . 81

*1.2. Spectroscopy, transitions in ions*

High precision measurements of forbidden transitions in highly charged ions at the Heidelberg EBIT
J.R. Crespo López-Urrutia, A. Artemyev, J. Braun, G. Brenner, H. Bruhns, I.N. Draganič, A.J. González Martínez, A. Lapierre, V. Mironov, J. Scofield, R. Soria Orts, H. Tawara, M. Trinczek, I. Tupytsin and J. Ullrich . . . . . 85
Modern methods of multiconfiguration studies of many-electron highly charged ions
P. Bogdanovich . . . . . 92
Relativistic calculations for highly charged ions
C.F. Fischer . . . . . 100
Atomic radiative transition probabilities using negative-energy orbitals in fully variational wave functions
O. Jitrik and C.F. Bunge . . . . . 105
Natural widths of hypersatellite K-X-ray lines and lifetimes of double K-hole states in mid-Z atoms
J. Rzadkiewicz, D. Chmielewska, Z. Sujkowski, M. Berset, J.-Cl. Dousse, Y.-P. Maillard, O. Mauron, P.-A. Raboud, M. Polasik, K. Słabkowska, J. Hoszowska and M. Pajek . . . . . 110
Laboratory simulation of cometary X-rays using a high-resolution microcalorimeter
P. Beiersdorfer, H. Chen, K.R. Boyce, G.V. Brown, R.L. Kelley, C.A. Kilbourne, F.S. Porter and S.M. Kahn . . . . . 116
Spatially resolved X-ray spectroscopy of an ECR plasma – indication for evaporative cooling
E. Takács, B. Radics, C.I. Szabó, S. Biri, L.T. Hudson, J. Imrek, B. Juhász, T. Suta, A. Valek and J. Pálinkás. . . . . 120
EUV spectroscopy of highly charged xenon ions
C. Biedermann, R. Radtke, G. Fußmann, J.L. Schwob and P. Mandelbaum. . . . . 126
Comparisons of laboratory wavelength measurements with theoretical calculations for neon-like through lithium-like argon, sulfur and silicon
J.K. Lepson, P. Beiersdorfer, E. Behar and S.M. Kahn . . . . . 131
Application of the RACAH package for dealing with the expressions from the atomic shell model
O. Scharf, G. Gaigalas, S. Fritzsche, M. Gedvilas, E. Gaidamauskas and G. Kiršanskas . . . . . 135
Algebraic tools for studying the properties and behaviour of hydrogen-like ions
S. Fritzsche, A. Surzhykov, W.-D. Sepp and F. Koike . . . . . 140
Solving quasi-relativistic equations for hydrogen-like ions with account of the finite size of a nucleus
P. Bogdanovich, V. Jonauskas and O. Rancova . . . . . 145
Optimization of coupling scheme in $2p^N3l$ ($N = 2$, 3, 4 and $l =$ s, p, d) isoelectronic sequences
T. Žalandauskas, G. Gaigalas and Z. Rudzikas . . . . . 149
Calculation of HCI spectra using their global characteristics
S. Kučas, V. Jonauskas and R. Karazija . . . . . 155
X-ray spectroscopy of Be- to He-like germanium
G. Zschornack, S. Landgraf, F. Grossmann, U. Kentsch, V.P. Ovsyannikov, M. Schmidt and F. Ullmann 160
Oscillator strengths for $(1s^22pnL)L$ states of beryllium isoelectronic sequence
M.-K. Chen. . . . . 165
Relativistic transition probabilities for F-like ions with $10 \leqslant Z \leqslant 49$
J.P. Santos, C. Madruga, F. Parente and P. Indelicato . . . . . 171

The theoretical study of spectral characteristics of Ar X
P. Bogdanovich and R. Karpuškienė . . . . . 174
Dependence of shake probability on nuclear charge in Li-, Na- and K-like ions
A. Kupliauskienė and K. Glemža . . . . . 180
The effective operator for the Auger $l_1^{N_1} l_2^{N_2} l_3^{N_3} \rightarrow l_1^{N_1+1} l_2^{N_2-1} l_3^{N_3-1} \varepsilon l_4$ transitions
G. Merkelis . . . . . 184
Precision lifetime measurement of the 2p $^2P_{3/2}$ level for Li-like Ni by beam-foil spectroscopy
Y. Zou, R. Hutton, D. Feili, C. Neacsu, X. Ma, K.-H. Schartner and P.H. Mokler. . . . . 192
Lifetime measurement of the metastable $2\,^3P_0$ state in He-like uranium
S. Toleikis, B. Manil, G. Bednarz, E. Berdermann, H.F. Beyer, F. Bosch, A. Bräuning-Demian, A. Gumberidze, P. Indelicato, C. Kozhuharov, D. Liesen, R. Marrus, P.H. Mokler, Z. Stachura, T. Stöhlker and A. Warczak. . . . . 197
Plans for laser spectroscopy of trapped cold hydrogen-like HCI
D.F.A. Winters, A.M. Abdulla, J.R. Castrejón Pita, A. de Lange, D.M. Segal and R.C. Thompson . . . 201
X-ray energies of circular transitions in sigmonic atoms
J.P. Santos, F. Parente, S. Boucard and P. Indelicato . . . . . 206

## 2. Highly charged ions: Interactions with photons, plasmas and related processes in strong fields

### *2.1. Strong laser fields*

Cluster-laser interaction: fast production of hot electrons by short laser pulses
C. Deiss, N. Rohringer and J. Burgdörfer . . . . . 210
Multiple ionization of ions and atoms by intense ultrafast laser pulses
M. Suresh, J. McKenna, B. Srigengan, I.D. Williams, E.M.L. English, S.L. Stebbings, W.A. Bryan, W.R. Newell, E.J. Divall, C.J. Hooker and A.J. Langley . . . . . 216
Recoil-ion momentum spectroscopy of multiply charged argon ions produced by intense ($\sim 10^{16}$ W cm$^{-2}$) laser light
H. Shimada, Y. Nakai, H. Oyama, K. Ando, T. Kambara, A. Hatakeyama and Y. Yamazaki. . . . . 221
Design considerations for a Johann X-ray crystal spectrometer using double reflection in a single crystal to obtain spatially resolved information about a hot plasma seeded with highly charged ions
B.S. Fraenkel, Z.H. Kalman, M. Bitter, J. Rice and A. Ince-Cushman . . . . . 226

## 3. Collisions with electrons, ions, atoms and molecules

### *3.1. Collisions with electrons*

Measurement of electron impact collisional excitation cross sections of Ni to Ga-Like Gold
M.J. May, P. Beiersdorfer, N. Jordan, J.H. Scofield, K.J. Reed, S.B. Hansen, K.B. Fournier, M.F. Gu, G.V. Brown, F.S. Porter, R. Kelley, C.A. Kilbourne and K.R. Boyce . . . . . 231
Dirac–Fock method study on the structure and shapes of various $KL^1$ X-ray satellite lines of terbium and tantalum
M. Lewandowska-Robak and M. Polasik. . . . . 235
Systematic Dirac–Fock method study of the X-ray spectra accompanying the ionization in collision processes: The structure of the $K\beta_2 L^0 M^r$ lines
K. Słabkowska, M. Polasik and J. Rzadkiewicz . . . . . 240
Collision strengths and rate coefficients for excitation of He-like ions by electron impact
S. Nakazaki, A. Ohsaki, E. Kimura, K.A. Berrington and P.H. Norrington . . . . . 245
Polarization of radiation emitted from He-like ions following electron impact
T. Kai, S. Nakazaki and K.A. Berrington . . . . . 249

*3.2. Dielectric recombination, radiative electron capture*

Investigation of fluorescence radiation following radiative recombination of ions and electrons
A. Kupliauskienė . . . . . 252
General expression for the dielectronic recombination cross section of polarized ions with polarized electrons
A. Kupliauskienė and V. Tutlys . . . . . 257
Dielectronic recombination of hydrogen-like ions
H. Watanabe, A.P. Kavanagh, H. Kuramoto, Y.M. Li, N. Nakamura, S. Ohtani, B.E. O'Rourke, A. Sato, H. Tawara, X.M. Tong and F.J. Currell . . . . . 261
Hyperfine quenching of resonances in dielectronic recombination of zinc-like $Pt^{48+}$
S. Schippers, G. Gwinner, C. Brandau, S. Böhm, M. Grieser, S. Kieslich, H. Knopp, A. Müller, R. Repnow, D. Schwalm and A. Wolf . . . . . 265
Negative-continuum dielectronic recombination into low-lying bound states of heavy ions
A.N. Artemyev, A.E. Klasnikov, T. Beier, J. Eichler, C. Kozhuharov, V.M. Shabaev, T. Stöhlker and V.A. Yerokhin . . . . . 270
Polarization and alignment transfer in heavy hydrogen-like ions following radiative electron capture
A. Surzhykov, S. Fritzsche, W.-D. Sepp, Th. Stöhlker and A. Oršić Muthig . . . . . 276
Charge state dependence of L-REC into highly charged U-ions
G. Bednarz, A. Warczak, D. Sierpowski, T. Stoehlker, S. Hagmann, F. Bosch, A. Gumberidze, C. Kozhuharov, D. Liesen, P.H. Mokler, X. Ma and Z. Stachura . . . . . 280
Polarization effects in radiative recombination of an electron with a highly charged ion
A.E. Klasnikov, V.M. Shabaev, A.N. Artemyev, A.V. Kovtun and T. Stöhlker . . . . . 284
Enhancement of low energy electron–ion recombination in a magnetic field: Influence of transient field effects
M. Hörndl, S. Yoshida, K. Tőkési and J. Burgdörfer . . . . . 290

*3.3. Collisions with atoms and ions*

Fully differential single ionization cross sections of helium by relativistic heavy-ion impact
M. Schulz, R. Moshammer, A. Voitkiv, B. Najjari and J. Ullrich . . . . . 296
Coupling and binding effects in L-shell ionization of heavy atoms by oxygen, silicon and sulphur ions
I. Fijał, M. Jaskóła, A. Korman, D. Banaś, J. Braziewicz, M. Czarnota, U. Majewska, M. Pajek, J. Semaniak, W. Kretschmer, D. Trautmann and T. Mukoyama . . . . . 301
Theoretical study of the Bethe surface in non-perturbative single ionization of He by swift highly charged ions
P.D. Fainstein and L. Gulyás . . . . . 306
Charge exchange and X-ray emission in 70 MeV/u Bi–Au collisions
P. Verma, P.H. Mokler, A. Bräuning-Demian, H. Bräuning, E. Berdermann, S. Chatterjee, A. Gumberidze, S. Hagmann, C. Kozhuharov, A. Orsic-Muthig, R. Reuschl, M. Schöffler, U. Spillmann, Th. Stöhlker, Z. Stachura, S. Tashenov and M.A. Wahab . . . . . 309
Classical and semiclassical treatments of highly charged ions + H(1s) collisions
L.F. Errea, C. Illescas, L. Méndez, B. Pons, A. Riera and J. Suárez . . . . . 315
Ionization of light atoms by ultra-fast ions
A.V. Selin and A.M. Ermolaev . . . . . 321
X-ray emission studies in relativistic collisions of Li-like uranium ions with gaseous target
D. Banaś, Th. Stöhlker, D.C. Ionescu, H.F. Beyer, F. Bosch, A. Bräuning-Demian, A. Gumberidze, S. Hagmann, C. Kozhuharov, X. Ma, P.H. Mokler, R. Mann, D. Sierpowski, S. Tachenov, Z. Stachura and A. Warczak . . . . . 326
EUV emission spectra from excited multiply charged xenon ions produced in charge-transfer collisions
H. Tanuma, H. Ohashi, E. Shibuya, N. Kobayashi, T. Okuno, S. Fujioka, H. Nishimura and K. Nishihara . . . . . 331

Semi-classical approaches to the ion–atom scattering
M. Janowicz, K. Słabkowska, P. Matuszak and M. Polasik . . . . . 337
K-shell ionization in (0.2–1.75) MeV/u Fe, Co + Cr and Fe + Cu collisions
C. Ciortea, I. Piticu, D. Fluerașu, D.E. Dumitriu, A. Enulescu, M.M. Gugiu, A.T. Radu and L.C. Penescu . . . . . 342
Multi-electron processes in large-angle scattering between slow $Ne^{q+}$ ($q = 1$, 2 and 3) and Ar
M. Hoshino, T. Kambara, Y. Kanai, R. Schuch and Y. Yamazaki . . . . . 347

*3.4. Collisions with molecules and clusters*

Collision dynamics of MCI-molecule systems studied by multi-coincidence technique
T. Kaneyasu, T. Azuma and K. Okuno . . . . . 352
Fingerprints of charge exchange between $He^{2+}$ and water molecules
D. Bodewits, A.G.G.M. Tielens, R. Morgenstern and R. Hoekstra . . . . . 358
Charge transfer in $H_2^+ - H(1s)$ collisions
L.F. Errea, A. Macías, L. Méndez, I. Rabadán and A. Riera . . . . . 362
Charge exchange processes for semi-relativistic helium ions ($\beta = 0.51$) in solid gold
A. Gójska, D. Chmielewska, J. Rzadkiewicz, Z. Sujkowski, T. Adachi, H. Fujita, Y. Fujita, K. Hara, Y. Haruyama, J. Kamiya, H. Ogawa, M. Saito, Y. Shimizu, Y. Shimbara, M. Tanaka, H.P. Yoshida and I. Katayama . . . . . 368
Charge transfer and dissociation of $H_2$ molecule in slow collisions with $C^{4+}$ ions
B. Zarour, C. Champion, J. Hanssen and B. Lasri . . . . . 374
Electron transfer and multi-ionization in slow collisions of $C_{60}$ with highly charged ions
B. Wei, X. Ma, X.L. Zhu, H.P. Liu, Z.L. Wang, S. Sha, W.T. Feng, S.P. Cao, D.B. Qian, B. Li and L.F. Chen. . . . . 378
Near-site far-site charge asymmetry in diatomic Coulomb fragmentation with slow highly charged ions
T. Ohyama-Yamaguchi and A. Ichimura . . . . . 382
Dissociation and fragmentation of $N_2$ molecules by slow highly charged ions
X.L. Zhu, X. Ma, B. Wei, H.P. Liu, Z.L. Wang, S. Sha, W.T. Feng, S.P. Cao, D.B. Qian, B. Li and L.F. Chen. . . . . 387
Fragmentation of adenine induced by collision with slow $F^{2+}$ ions
R. Brédy, J. Bernard, L. Chen, B. Wei, A. Salmoun, T. Bouchama, M.C. Buchet-Poulizac and S. Martin 392
Accelerating multiple scattering of the emitted electrons in collisions of ions with atoms and molecules
T. Ricsóka, Gy. Víkor, Sz. Nagy, K. Tőkési, Z. Berényi, B. Paripás, N. Stolterfoht and B. Sulik . . . . . 397
Sulphur ion charge states inside solids from low-resolution K X-ray spectra
J. Braziewicz, U. Majewska, M. Polasik, K. Słabkowska, I. Fijał, M. Jaskóła, A. Korman and W. Kretschmer . . . . . 403

**4. Interactions with clusters, surfaces and solids**

*4.1. Interactions with clusters*

Physical parameter dependence of the X-ray generation in intense laser–cluster interaction
E. Lamour, C. Prigent, J.P. Rozet and D. Vernhet . . . . . 408
Parent initial charge differentiated $C_{60}^{r+}$ fragmentation in low energy $He^+ - C_{60}$ collisions
B. Wei, L. Chen, R. Brédy, J. Bernard, M.C. Buchet-Poulizac and S. Martin . . . . . 414
Fragmentation of charged fullerene dimers: Kinetic energy release
B. Manil, L. Maunoury, J. Jensen, H. Cederquist, H.T. Schmidt, H. Zettergren, P. Hvelplund, S. Tomita and B.A. Huber. . . . . 419

*4.2. Interactions with surfaces*

Electron emission from surfaces induced by HCI and lasers
C. Lemell, X.-M. Tong, K. Tökesi, L. Wirtz and J. Burgdörfer . . . . . 425
Nanoscale modification of electronic states of HOPG by the single impact of HCI
T. Meguro, Y. Yamaguchi, H. Fukagawa, H. Takai, N. Hanano, Y. Yamamoto, K. Kobashi and T. Ishii 431
Energy- and angular-distributions of $F^+$ ions emitted from a F-terminated Si(100) surface with slow highly charged ions
N. Okabayashi, K. Komaki and Y. Yamazaki . . . . . 438
In and ex situ optical spectroscopy of HCI-bombarded solid surfaces
M. Tona, Y. Baba, S. Takahashi, K. Nagata, N. Nakamura, N. Yoshiyasu, C. Yamada and S. Ohtani 443
Reflection of nitrogen ions from copper surface: Experiment and calculations
N.V. Novikov, Ya.A. Teplova, Yu.A. Fainberg and V.S. Kulikauskas . . . . . 448
Observation of an HCI-induced nano-dot on an HOPG surface with STM and AFM
M. Terada, N. Nakamura, Y. Nakai, Y. Kanai, S. Ohtani, K.-i. Komaki and Y. Yamazaki. . . . . 452
Observation of surface modification and secondary particle emission in HCI–surface interaction
S. Takahashi, M. Tona, K. Nagata, N. Yoshiyasu, N. Nakamura, M. Sakurai, C. Yamada and S. Ohtani 456

*4.3. Interactions with solids*

Guiding of slow neon and molecular hydrogen ions through nanocapillaries in PET
N. Stolterfoht, R. Hellhammer, P. Sobocinski, Z.D. Pešić, J. Bundesmann, B. Sulik, M.B. Shah, K. Dunn, J. Pedregosa and R.W. McCullough . . . . . 460
X-rays emitted from N ions transmitted through a thin Ni microcapillary target
Y. Iwai, Y. Kanai, Y. Nakai, T. Ikeda, M. Hoshino, H. Oyama, K. Ando, H. Masuda, K. Nishio, H.A. Torii, K. Komaki and Y. Yamazaki . . . . . 468

**5. Highly charged ions: Production, experimental developments and applications**

*5.1. Traps*

Trapping ions of hydrogen-like uranium: The HITRAP project at GSI
T. Beier, L. Dahl, H.-J. Kluge, C. Kozhuharov, W. Quint and the HITRAP collaboration . . . . . 473
RETrap – a cryogenic Penning ion trap system
S. Toleikis, R. Maruyama, D.A. Church, D. Schneider, S.J. Freedman, I. Kominis and P.A. Vetter . . . 479
A novel trochoidal analyzer for the Belfast EBIT
A.P. Kavanagh, H. Watanabe, H. Tawara, A.F. Morton and F.J. Currell . . . . . 482

*5.2. Experimental facilities and set-up*

Next generation ECR ion sources: First results of the superconducting 28 GHz ECRIS – VENUS
D. Leitner, C.M. Lyneis, S.R. Abbott, D. Collins, R.D. Dwinell, M.L. Galloway, M. Leitner and D.S. Todd . . . . . 486
Atomic physics with highly-charged heavy ions at the GSI future facility: The scientific program of the SPARC collaboration
Th. Stöhlker, T. Beier, H.F. Beyer, F. Bosch, A. Bräuning-Demian, A. Gumberidze, S. Hagmann, C. Kozhuharov, Th. Kühl, D. Liesen, R. Mann, P.H. Mokler, W. Quint, R. Schuch and A. Warczak. . . . 494
Production of highly charged ions with an ECRIS using high temperature super-conducting coils
C. Bieth, S. Kantas, P. Sortais, D. Kanjilal, G. Rodrigues, S. Milward, S. Harrison and R. Mc Mahon 498
Simultaneous cooling of highly charged ions with electrons and positrons
N. Oshima, M. Niigaki, M. Lebois, A. Mohri, K. Komaki and Y. Yamazaki . . . . . 504

Status of the Shanghai EBIT
X. Zhu, Y. Liu, X. Wang, Y. Liu, P. Guo, D. Lu, X. Zhang, W. Hu, M. He, L. Liljeby and Y. Zou . . 509
Dresden EBIT: The next generation
G. Zschornack, St. Landgraf, F. Grossmann, U. Kentsch, V.P. Ovsyannikov, M. Schmidt and F. Ullmann . . . . . 514
Development of electron beam ion source for nanoprocess using highly charged ions
M. Sakurai, F. Nakajima, T. Fukumoto, N. Nakamura, S. Ohtani, S. Mashiko and H. Sakaue . . . . . 519
Brief review of multiple charge state ECR ion sources in Lanzhou
L.T. Sun, H.W. Zhao, Z.M. Zhang, B. Wei, X.Z. Zhang, X.H. Guo, X.W. Ma, Y. Cao, W. He and H.Y. Zhao. . . . . 524
Quantum efficiency of back-illuminated CCD detectors in the VUV region (30–200 nm)
H.P. Garnir and P.-H. Lefèbvre . . . . . 530
Optimization of the energy resolution of an ideal ESCA-type hemispherical analyzer
T.J.M. Zouros, E.P. Benis and I. Chatzakis . . . . . 535

Author index . . . . . 540